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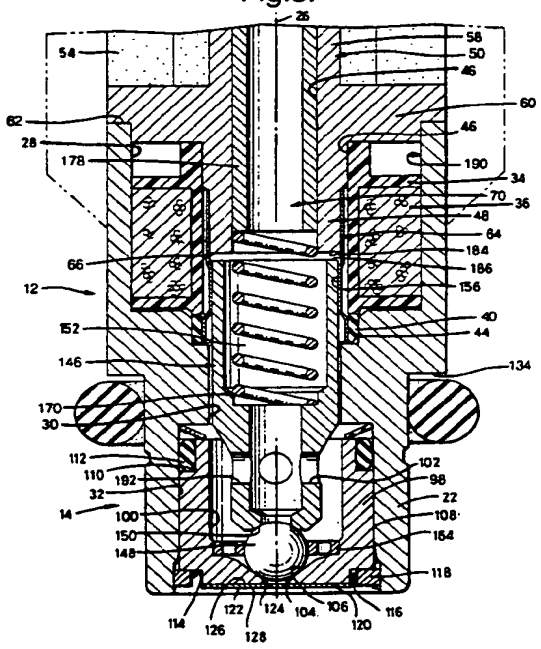
(54) Fuel injector valve seat retention

(57) A fuel injector is disclosed and has a tubular injector body with a fuel passage (70) extending therethrough. A solenoid actuator is disposed intermediate of the fuel passage and a nozzle body (98), having a fuel opening (104) surrounded by an annular valve seat (106) is located downstream of the actuator, between the actuator and an end of the passage. The nozzle body (98) is configured for sliding engagement with the inner wall of the fuel passage and a valve assembly operates with the solenoid actuator and the nozzle body (98) to meter fuel through the annular valve seat (106). A radially outwardly biased ring member (118) is disposed in the fuel passage, between said nozzle body (98) and the end of the fuel passage and operates to exert an outwardly directed force ("F") on the inner wall of the tubular injector fuel passage to thereby establish a frictional resistance to axial movement of the nozzle body (98) towards the end of the fuel passage. In a preferred embodiment, the retainer ring (118) abutting a lower surface of the nozzle body in an annular grooved portion (116) thereof to thereby recess the retaining ring (118) in the nozzle body lower surface and minimize the surrounding surface area which is subject to fuel wetting. The retaining ring (118) may be welded to the nozzle body (98) and the tubular injector body to fix the nozzle body axially.

Fig.3.



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Solenoid assembly 18 is disposed within the enlarged upper solenoid case portion 20 and includes a spool-like, tubular bobbin 34 supporting a wound wire solenoid coil 36. A resilient sealing member such as o-ring 40 is disposed between the tubular bobbin 34 and a seal shoulder 44. The bobbin 34 is provided with a central through bore 46 configured to encircle the lower, reduced diameter portion 48 of pole piece 50. A pair of terminal leads 52 are operatively connected at one end to the solenoid coil 36 and each such lead has its second end extending upwardly through an outer, overmolded casing 54 to terminate in a terminal socket 56, for connection of the fuel injector to a suitable source of electrical power in a manner well known in the art.

Pole piece 50 includes an upper cylindrical portion 58, a centrally located flange portion 60 and the lower reduced diameter cylindrical pole 48. The circular, radial flange portion 60 is slidably received at its outer peripheral edge within the cylindrical upper wall 28 of the body 12 to thereby close the enlarged upper solenoid case portion 20 of the body 12 and retain the solenoid assembly 18 therein. The pole piece 50 is axially retained within the upper cylindrical portion of the body 12 as by having its flange portion welded or otherwise suitably bonded to the shoulder 62 along the upper, opened end of wall 28.

Formed integral with the pole piece 50 and extending downwardly from the flanged portion 60 is the lower cylindrical pole 48. Pole 48 is of a suitable exterior diameter so as to be slidably received in the central through bore 46 that extends coaxially through the coil bobbin 34. Received about the lower end of the lower cylindrical pole 48 of the pole piece 50 is a cylindrical tube 64 of non-magnetic material such as stamped or drawn metal. The tube 64 extends axially downwardly beyond the lower end 66 of the lower cylindrical pole 48. The outer surface of the extended portion of the tube 64 acts as an interface with resilient sealing member 40 seated between the lower end of the coil bobbin extension 42 and seal shoulder 44 of the body 12, thereby operating to seal the central, fuel passage 70 of the fuel injector 10 from solenoid coil 36.

The pole piece 50, is provided with a boss 58 which is configured to receive fuel inlet tube 74. The fuel inlet tube 74 is encapsulated within overmolded upper housing 54 which is formed of a suitable encapsulant material. An upper seal shoulder 86 formed in the overmolded housing 54 is axially spaced from the tube flange 78 to define an annular seal groove 88 configured to carry a resilient sealing member such as o-ring 90 for leak free attachment to a source of pressurized fuel, not shown.

The nozzle assembly 14 includes a nozzle body 98 having a cup-shaped tubular configuration with an inner wall 100 defining a fuel cavity 102. The fuel cavity includes an axially aligned fuel discharge opening 104 surrounded by a frustoconical valve seat 106. A cylindrical outer wall 108 further defines the nozzle assembly 14 and is configured for sliding disposition within the cylindrical lower wall 32 of the nozzle case portion 22 of injector body 12. A circumferentially extending annular groove 110 is disposed in the cylindrical outer wall 108 adjacent the end of the nozzle body 98 and is configured to receive a resilient sealing member such as o-ring 112. The o-ring 112 establishes a seal against leakage out of the injector 10 by interfacing with the cylindrical lower wall 32 of the injector body 12.

In a preferred embodiment of the injector 10, Figures 4 and 5, a circumferentially extending shoulder 114 is disposed in the downstream, outer surface 108 of the nozzle body 98. Upon disposition of the nozzle body 98 within the lower end, nozzle case portion 22 of the injector body 10, the cylindrical lower wall 32 and the shoulder 114 of the nozzle body cooperate to define a groove 116 in which is disposed an outwardly biased, circular retaining ring 118. The retaining ring 118 is operable to exert a radially outwardly directed force "F" on the cylindrical lower wall 32 of the nozzle body 98 which, in turn, establishes a frictional resistance to axial movement of the ring and associated nozzle body within the lower case portion of the nozzle body 12.

In one preferred embodiment of the retaining ring, illustrated in Figure 4, the ring 118 is defined by non-uniform cross-section. The use of a ring 118 having such non-uniform cross-section allows for a uniform, radially outwardly directed force to be imparted by the retaining ring on the cylindrical wall 32 as compression of a ring having such a cross-section is known to impart a more uniform force component about its circumference than one having a uniform cross section.

Over a portion of the exterior, lower end 120 of the nozzle body 98 is placed a fuel spray director plate 122. The director plate 122 is a flat plate member formed of thin sheet stock and having fuel directing openings 124 extending from the upstream side 126 to the downstream side 128. Fuel passing through the fuel discharge opening 104 in the valve seat 106 is delivered to the upstream side, or face 126 of the director plate 122 where it is distributed across the face to the fuel openings 124. The openings 124 are oriented in a predetermined configuration which will generate, in the discharged fuel, a desired spray configuration. By locating the nozzle retaining ring 118 within the groove 116 formed through the association of the shoulder 114 and lower cylindrical wall 32 of body 12, the ring is recessed relative to the lower surface 122 of the nozzle body 98 to limit the surface area which is exposed to the spray departing the openings 124 in the director plate 122. Such reduction in downstream surface area is desirable in that it reduces the incidence of fuel impingement on such surfaces and wetting of those surfaces which may adversely affect the performance of the fuel system.

Assembly and calibration of the fuel injector 10 may require axial translation of the nozzle body 98 to set the stroke of the valve member 16. The use of the retaining ring 118 adjacent the downstream end of the nozzle body 98 allows the injector 10 to be assembled and the nozzle body to be axially adjusted during calibration

3. A fuel injector, as defined in claim 1, said nozzle body (98) axially adjustable within said fuel passage (70) of said injector body (12), through imposition of an axial force component sufficient to overcome said frictional resistance of said retaining ring.

4. A fuel injector, as defined in claim 1, said retaining ring weldable to said nozzle body and said injector body.

5. A fuel injector comprising a tubular injector body having a fuel passage (70), defining an inner wall (28,30,32), having first and second ends, a solenoid actuator (18) disposed intermediate of said first and second ends, a nozzle body (98), comprising a fuel opening (104) surrounded by an annular valve seat (106), located between said solenoid actuator and said second end, in sliding engagement with said inner wall, a valve assembly (148) operable with said solenoid actuator and said nozzle body to meter fuel through said injector, and a radially outwardly biased ring member (118), disposed in said fuel passage, between said nozzle body and said second end of said fuel passage and operable to exert an outwardly directed force on said inner wall to thereby establish a frictional resistance to axial movement of said nozzle body in the direction of said second end and said nozzle body axially adjustable through imposition of an axial force component sufficient to overcome said frictional resistance to axial movement of said retaining ring.

6. A fuel injector, as defined in claim 5, said retaining ring comprising a non-uniform cross-section effective to impart a uniform, radially outwardly directed force on said axial fuel passage of said injector along a line of contact therebetween.

7. A fuel injector, as defined in claim 5, said retaining ring weldable to said nozzle body and said injector body.

Fig.2.

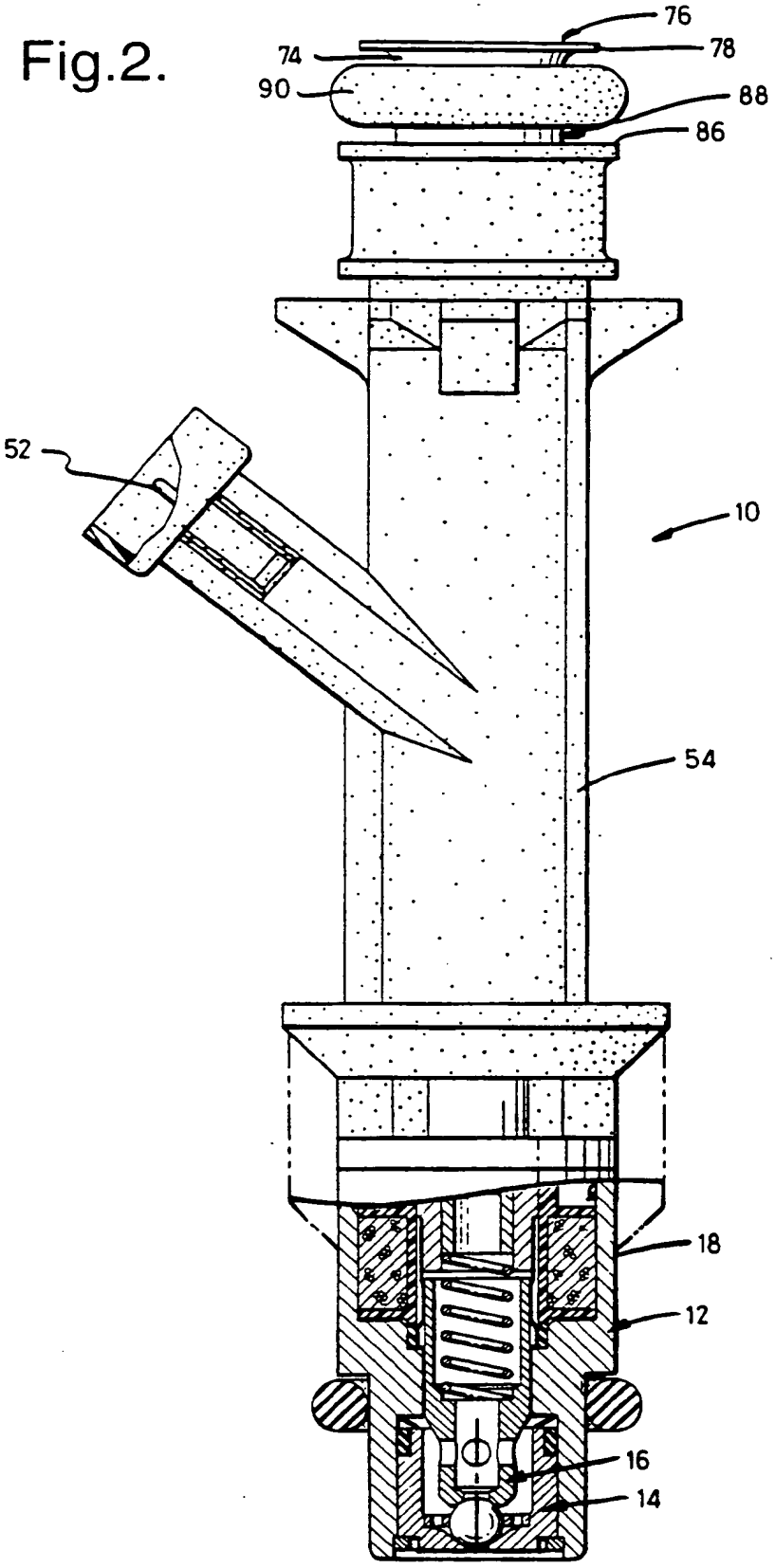


Fig.4.

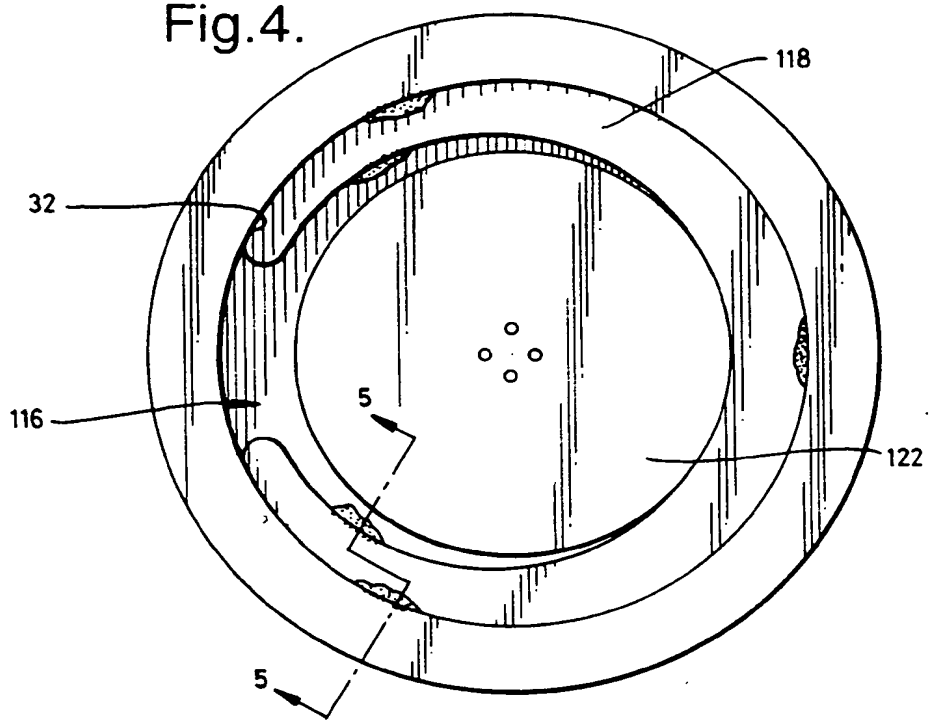
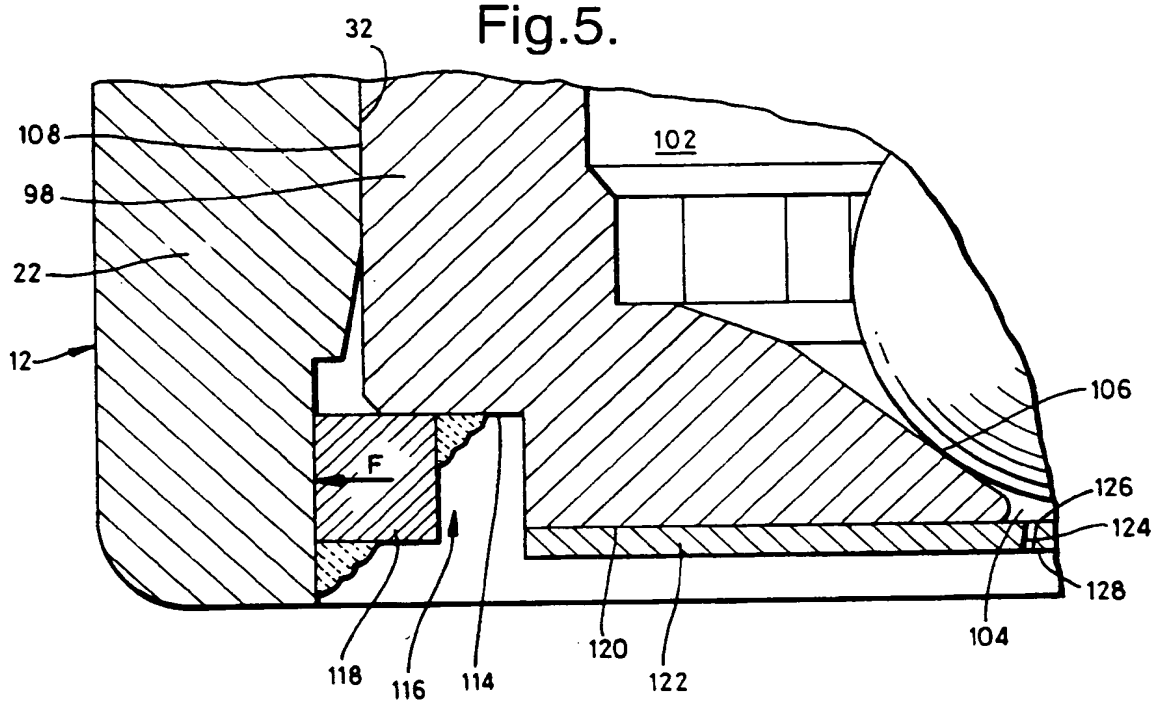


Fig.5.



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EUROPEAN SEARCH REPORT

Application Number
EP 96 20 3325

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 335 864 A (ROMANN PETER ET AL) 9 August 1994 * column 1, line 30 - column 3, line 15; figure *	1,3-5,7	F02M61/18 F02M51/08
A	US 5 207 384 A (HORSTING JOHN J) 4 May 1993 * column 2, line 24 - line 47; figures 1,3 *	1,3-5,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 March 1997	Torle, E

CATEGORY OF CITED DOCUMENTS

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